TN # 1

14 November 1955

TEST PILOT EVALUATION OF "THE ANGEL"

1. INTRODUCTION

a. Objective: The purpose of these tests is to evaluate subject airplane for flight safety deficiencies and to recommend changes to increase the potential of the airplane with the present and proposed articles.

b. Authority: The authority for these tests was given by the Chief of Staff, HQ, USAF.

c. History: Four flights were made by [redacted] 25X1 on 8 and 9 November 1955 consisting of 5+40 hours flying time. The first two flights were made in #343 (third article) at a gross weight of 15,725 lbs. at a C.G. of 27% MAC with 735 gal. of fuel. The third flight was in #343 also, at a gross weight of 14,450 lbs. with only 535 gal. of fuel. C.G. was also 27%. The fourth flight was made in #341 (first article) at a gross weight of 14,425 lbs. with 535 gal. of fuel. C.G. for the fourth flight was 25.6%.

The first flight was to check low speed and low altitude (45,000 ft. max.) characteristics. Several touch and go landings were made and general flight control tests were made. The second and third flights were to maximum altitude (70,300 ft. was highest made) to check flight characteristics at high altitude and high speed. The fourth flight was in #341 which had been painted, stabilizer angle of incidence changed and modified fuel control. Maximum altitude obtained was 66,000 at which time thrust decay was noted, resulting in aborting any further attempts to climb higher.

d. Description of Test Aircraft:

(1) "The Angel" is designed only to fly at extreme altitudes at low Mach No. (.8) and low indicated speed (260 kts. max.). Primary mission is high altitude reconnaissance or "Ferret" type missions.

(2) The airplane consists of a single high wing, bicycle type landing gear with two droppable wing "pogo" gears used only for the take-off roll. The engine installed is a J-57/P-37 turbojet rated at 10500 thrust. A unique feature incorporated which is not used in other military airplanes is the "gust control". This control raises the flaps and ailerons to relieve gust loading and will permit higher indicated speeds during turbulent conditions.

(3) The single place cockpit is simple and straightforward with little to complain about as pertains to arrangement of controls, switches, instruments, etc.

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(4) The high altitude capability dictates a high aspect ratio type design which this airplane has. The aspect ratio is 10.67. Empty gross weight is 11,000 with a maximum take-off gross weight of 17,500 carrying 935 gallons of fuel. A maximum overload gross may be used of 20,000 by carrying 1,335 gallons of fuel.

2. DISCUSSION OF RESULTS

a. Taxiing: The airplane is not taxied prior to take-off but is towed to take-off position. After landing, the airplane may be taxied if unrestricted area is available but airspeed should be kept at 40-50 kts. to maintain aileron control to prevent excessive wing tip drag. Also, flaps should be retracted for taxiing as flaps greatly reduce aileron effectiveness. The airplane cannot be turned around on a runway because of the large turning radius required. The tail wheel is steerable with the rudder pedals 6° either side of center.

b. Take-off and Climb: The take-off is quite simple and easily performed. The airplane accelerates rapidly and is airborne before the pilot realizes it. Until the pilot has become proficient in the take-off characteristics some difficulty may be experienced during crosswind conditions. The tail wheel steering and rudder effectiveness is very low. However, because of the short take-off ~~roll and~~ rapid acceleration, crosswind take-offs are considered feasible after pilot has gained experience. Proper technique for take-off is as follows. Run power up to 65% and release brakes. After brake release, advance power to 85%. As pilot experience is gained, full power take-offs may be made. At 50-60 kts. release "pogo" wing gear and at the same time gently ease back on the control wheel. Airplane will become airborne between 70-80 kts. (depending upon gross weight) and immediately after becoming airborne raise landing gear. Nose must be pulled up sharply to prevent exceeding gear retraction speed of 130 kts. After gear is up and locked, increase climb speed to 160 kts. The climb attitude to approximately 15,000 feet is quite steep and pilot is more or less "hanging on". Visibility during this part of the climb is virtually nil because of the exaggerated nose-up climb angle, and the pilot generally refers to his flight instruments to maintain attitude. After 15,000 feet the angle of climb is less and pilot then has time to orient himself and start mission planning. Climb speed of 160 should be held to an altitude of 50,000 feet. At this altitude speed should be reduced to 150 kts. until the Mach limit needle reaches 160 kts. At this time the climb speed should be held 10 kts. under the Mach limit needle for the remainder of the mission. Climb cruise condition will start at approximately 65,000 feet. Approximate time to climb from brake release is as follows. Take-off attitude was approximately 4,000.

35,000	6 min.	55,000	12 min.
40,000	7 min.	60,000	15 min.
45,000	8.5 min.	65,000	20 min.
50,000	10 min.	70,000	27 min.

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These climbs were at fairly light gross weights and should not be construed as accurate for a profile mission. Also they were timed by stop watch and not reduced to standard day conditions.

c. Cruise and Maneuvering Flight:

(1) Inasmuch as this airplane is very restricted, the cruise and maneuvering flight envelope is small. For safety purposes the following limitations are imposed.

Heavy weights	2.5 "g"
Light weights	3.5 "g"
Clean-smooth air	220 kts. or .8 Mach
Clean-rough air	150 kts. or .8 Mach
Gust control on smooth air	260 kts. or .8 Mach
Gust control on rough air	220 kts. or .8 Mach
Flaps down	130 kts.
Gear extension	200 kts.
Gear retraction	130 kts.

Cruise at high altitude (70,000) is fairly simple. Caution must be exercised to prevent exceeding limit Mach No. but other than that the airplane handles well. At altitude above 60,000 the pilot must use the throttle vernier to manipulate power as fine adjustments are necessary to prevent exceeding limit temperature and engine speed. The pilot must use the pressure ratio gauge and exhaust temperature gauge to monitor proper power. Also, again it should be noted that the speed must be kept to 10 kts. under Mach limit as thrust and temperature will vary with airspeed. Also, for interest, it should be noted that a 10 kt. change in speed at high altitude results in a 40 kt. true speed loss. Also at 70,000, when flying into the sun, the heat upon the face is very uncomfortable. Curtains should be provided for sun shades. Cockpit temperature is adequate except when letting down. Very little heat is provided because of low engine rpm. Pilots may desire slowing rate of descent at lower altitudes (40,000 and below) by adding power to provide heat. In #343 the oil and smoke expelled through the air-conditioning system is unacceptable. The filter installed in #341 eliminates the oil and smoke and should be installed in all airplanes. Bank angles of 60° were made at 70,000 feet with no adverse characteristics being encountered. Level flight turns may be made at approximately 20° bank angles with altitude loss increasing at bank angle above 20°. At 60° bank angle rate of descent is approximately 1000 feet per minute.

(2) The static stability, both stick free and stick fixed, is positive about all three axes. Dynamic longitudinal stabilizer is dead beat as is the lateral. The dihedral effect is non-existent. Dynamic directional does not fall within 1815 B spec. requirements; however, the directional oscillation is of low frequency and is easily

controllable with rudder. Also the moderate amount of adverse yaw encountered is readily controlled with rudder.

(3) Both elevator and rudder control forces are satisfactory. Stick force per "g" is also acceptable; however, the aileron forces are atrocious. This is noticed immediately after take-off and the force increases with speed. This condition causes pilot fatigue and it is recommended that the aileron forces be greatly reduced if practicable.

(4) During cruising flight airplane response to elevator and aileron control is immediate and the controls are effective. Response to rudder is slow and rudder effectiveness is not acceptable. However, because of the non-existent dihedral effect and symmetrical flight conditions, the rudder is very seldom used. Rate of roll is low and decreases with speed increase. It is acceptable for the purpose for which this airplane was designed, however.

d. High Speed Flight:

(1) Airplane #343 (3rd article). This airplane was flown to 260 kts. indicated and .8 Mach No. No adverse condition was noted at the high "q" limit. Stick force per "g" is high and the rate of roll is approximately 20° per second which is desirable, considering the design limits and construction. At .8 Mach No. there is a light aileron nibble followed by a slight nose-down pitching movement. The pitching movement is controllable and it is felt that there is plenty of warning to prevent exceeding limit Mach No. if caution is properly exercised. It is recommended that a slight nose-up trim be used at extreme altitudes requiring a slight push force on the wheel on the part of the pilot to prevent inadvertently exceeding limit Mach No. It would be desirable to have an automatic pilot on the longitudinal control to relieve pilot concentration and permit him to attend to other duties without concerning himself about maintaining proper airspeed or worry about exceeding limit Mach No.

(2) Airplane #341 (modified 1st article). Because of the paint or the stabilizer modification of this airplane, or both, this airplane felt better generally during all flight maneuvers. At high "q" flight (260 kts.) less forward elevator is required and results in less pilot effort when flying at these speeds. When checking the high Mach No. characteristics, however, it was quite startling to find that a high frequency, moderate amplitude, rudder buffet occurred at .82 Mach No. with no warning whatsoever. This had not been experienced before by the contractor; thus any further testing was terminated until engineering analysis could be made. The lack of any warning is not considered acceptable and the undersigned would prefer to fly the unmodified airplane which has a definite Mach limit warning.

(3) It is recommended that descents from high altitude be made as follows. Extend gear and dive brakes. By using throttle vernier reduce thrust to pressure ratio reading recommended by contractor. Power reduction is continued in this manner until reaching 50,000 at which time power may be reduced to idle. Put airplane in 60° bank and hold speed 10 kts. below limit Mach. More caution is needed during descents as dive brake buffet will tend to mask the Mach buffet. It takes approximately 8 minutes to reach 50,000 from 70,000 feet. Dive brake effectiveness is very low and should be increased by 200% or more. This is considered one of the main deficiencies of the airplane.

e. Trim Controls and Trim Changes: The aileron and elevator have electrical trim tabs actuated by switches. The rudder trim consists only of a metal tab adjusted from the outside. The elevator switch is on the right side of the wheel while the aileron switch is on the left console. The aileron switch should be incorporated with the elevator switch as a four-way switch. Both aileron and elevator trim speeds are far too slow and should be increased at least by 100%. This is especially true of the elevator. There is very little trim change with either gear actuation or thrust changes. There is a nose-up trim change when extending the dive brakes above 150 kts. that increases slightly with speed increase but easily controllable with elevator. Very little trim change is noticed when using dive brakes below 150 kts. There is a fairly heavy trim change when actuating the gust controls and the pilot must concentrate to maintain same attitude when actuating the gust control. The extension of gust control causes a nose-up pitching movement and vice versa upon retraction. When extending the landing flaps there is a nose-down trim change that also requires pilot attention to maintain attitude. These trims changes are rapid enough that elevator trim speed cannot keep up, thus the requirement for increased elevator trim speed. Trim changes, in all cases, are in the proper direction and are considered acceptable.

f. Stalls and Low Speed Handling:

(1) Accelerated stalls are mild and straightforward. There is an airframe buffet approximately 5 kts. above stall and a nose-down pitching movement at the stall. Stall recovery is easily made by releasing back pressure on control wheel.

(2) Clean unaccelerated stalls are considered mild and stall warning is evidenced by a slight airframe buffet approximately 5 kts. above stall. Stall warning starts at approximately 83 kts. with airplane stalling at 77 kts. There is a yawing oscillation of approximately 5° during the stall that cannot be readily controlled by the rudder. At the same time there is a slight lateral oscillation that is controllable with ailerons.

(3) As flaps are extended both stall warning and stall speed is reduced approximately 2 kts. for every 10° of flap. A maximum of 30° of flaps is available. At the stall with 30° of flaps there is a sudden right wing drop with a right yawing movement. Neither of these characteristics are controllable and the stalling characteristics or lack of warning is not considered acceptable. Stall speed with flaps is approximately 71 kts.

g. Approach and Landing: The approach and landing of this airplane is the most difficult maneuver of any to perform. The airplane is quite difficult and unwilling to slow down to the proper approach speed of 90-100 kts. Flaps aid in reducing speed; however, the flaps reduce aileron effectiveness approximately 70% and increase aileron force approximately 50%. With the high aileron forces and low aileron effectiveness, the pilot is quite unwilling to use flaps especially during turbulent air and crosswind conditions. The base leg must be flown low (200-300 ft.) and over the fence altitude is approximately 10-20 feet. Because of the thrust being produced at idle power combined with low airplane drag, it is virtually impossible to "spot" a landing. Also ground effect very definitely will cause the airplane to float considerably. Because of the B-47 type arrangement of the gear, a two-point or rear wheel landing must be made to prevent porpoising which could become dangerous if the pilot overcontrols or bounces too high after permitting the front truck to hit first. Further, because of the low rudder effectiveness difficulty will be encountered, when attempting crosswind landings, in maintaining runway alignment. As the airplane must virtually be stalled to land, the heretofore mentioned stalling characteristics are not compatible with airplane longevity. Thus the requirement for a drag chute or increased dive brake effectiveness is again necessary to shorten floating and landing distance after touchdown. The low rudder and tail wheel steering effectiveness dictates a requirement for nose wheel steering in order that pilots may maintain directional control.

The recommended landing and approach procedures are as follows: Enter initial overhead pattern 500 feet above runway at approximately 130 kts. Turn onto base leg at 200-300 feet and lower 10% flaps. Turn on the final 1-2 miles from end of runway at 200 feet. Adjust power to permit descent at 85-90 kts. If wind conditions permit extend 30° of flaps one mile from end of runway. Cross end of runway at 80 kts., 2-3 feet high and reduce power to idle if not having already done so. Attempt to hold airplane 1-2 feet off runway until it stalls and lands at which time place power lever to idle cut off. If flaps are used, retract as soon as possible to realize more aileron effectiveness for lateral control. Use moderate to heavy wheel braking after airspeed reaches 40 kts. still attempting to maintain wing level attitude with ailerons. Dive brakes should be used throughout the approach and landing for what little drag they offer. It will be noticed that the

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ground effect reduces stalling speed approximately 5-10 kts.; however, caution must be exercised in that the airplane will stall at a higher speed if levelled off out of ground effect. With an adequate drag device it is felt that flaps would not be used thus increasing the aileron effectiveness and also realizing the better clear stalling characteristics. Further an adequate drag device would permit steeper approach angles, and possibly higher touchdown speeds with much shorter ground roll. As pilot experience is gained the engine may be cut on final approach to reduce the long floating distance.

3. CONCLUSIONS

It is concluded that the number 3 article (#343) or any other article employing the same fuel control schedule employed by #343, could perform the basic mission. Further, it is concluded that this airplane could not be adapted to the role of an interceptor because of its limiting Mach No. and maneuvering flight restrictions.

4. RECOMMENDATIONS

The first two recommendations are considered mandatory before releasing any of these airplanes to conduct missions.

a. It is recommended that:

(1) A much greater effective drag device be installed to decrease the letdown time from altitude and to permit steeper approach angles and shorter landing distances. This device will also delete the need of landing flaps.

(2) Nose wheel steering be installed replacing the tail wheel steering.

b. The following recommendations should be made as soon as possible without delaying the program:

(1) A Mach No. limit warning device be installed. This is especially necessary if the modifications made on #341 are to be incorporated on subsequent airplanes.

(2) Provide adequate stall warning in the approach configuration and improve the stalling characteristics.

(3) Install auto pilot so pilot may devote time to other duties.

(4) Install sun shades.

(5) Install filters in airconditioning system to prevent oil and smoke from entering cockpit.

(6) Reduce aileron forces by 200%.

(7) Increase elevator trim speed by 100%.

(8) Increase aileron trim speed 50%.

(9) Incorporate aileron trim switch with elevator switch as a single four-way switch.

(10) Increase rudder effectiveness for take-off and landing under crosswind conditions.

(11) Exchange the present oil pressure and temperature gauges with the instrument light and instrument panel lights for more ease of readability.

(12) Provide cover for periscope when not in use.

(13) Reduce the flap and dive brake buffet by 100%.

(14) Add mike button to left side of control wheel or relocate from throttle to left side of control wheel.

(15) Provide a better cover for the aft fuel tank empty warning light.

(16) Mark 150 kts. clean limit speed on airspeed indicator.

(17) Install large type sensitive "g" meter in place of small standard "g" meter.

(18) Improve automatic operation of heat control so pilot will not have to divert attention from other duties to continually operate heat control manually.

(19) Provide a more sensitive and accurate pressure ratio gauge.

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